WAS THERE A CATASTROPHIC COLLISION OF THE H CHONDRITE PARENT BODY ABOUT 200 m.y. AGO?

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Many L chondrites have low K-Ar and, especially, U,Th-He ages. Losses of radiogenic Ar and He may be stimulated by heating during the catastrophic collision of the parent body of these chondrites. Heymann [1] studied the distribution of ^{4}He and ^{3}He contents in 20 “black” L chondrites and concluded that the parent body of L chondrites underwent a catastrophic collision 520 ± 80 m.y. ago and cosmogenic ^{4}He/^{3}He production ratio was equal to B = 5.2 ±0.3. More detailed analyses of a greater number of L chondrites showed [2–4] the catastrophic collision was 340 ± 50 m.y. ago and the value of B = 6.0 ± 0.3.

H chondrites have mainly high gas-retention ages [5,6]. However, a small group of H chondrites obviously lost their radiogenic ^{40}Ar and ^{4}He. Possibly this loss was also stimulated by heating of the H chondrite parent body, but in a less catastrophic event than for the L chondrite body. For the determination of the time and scale of this event we selected H chondrites and analyzed the distribution of ^{4}He vs. ^{3}He contents in them. Initial data on the rare gas contents were take from [7]. Criteria for selection were the same as for L chondrites [4]: (1) the K-Ar and U,Th-He ages are less than 1.5 k.y., (2) the ratios of ^{20}Ne/^{22}Ne are less than 1.2 (for exclusion of meteorites with trapped “solar” gas), and (3) meteorites do not show considerable diffusion losses of gases (the decrease of (^{3}He/^{21}Ne)c relative to the correlation line in the dependence of (^{3}He/^{21}Ne)c vs. (^{22}Ne/^{21}Ne)c [8] is less than 20%).

Only six H chondrites among 479 in the compilation of [7] satisfied all the selection criteria (about 1.3%; for L chondrites this value was equal to 16.6%. [4]). Data for these H chondrites are given in Tables 1 and 2, and in Fig. 1. Coefficients of the “best” straight line for these six meteorites are A = (55.6 ± 10.8) × 10^{-8} cc STP/g and B = 5.8 ± 0.08. The B coefficient determines the ratio of ^{4}He and ^{3}He production rates in the meteorites under cosmic ray irradiation. The obtained values of B calculated by different methods are 5.8 ± 0.8, 5.7 ± 1.3, and 5.2 ± 0.9. They are in agreement with that obtained for L chondrites (6.0 ± 0.3) [4].

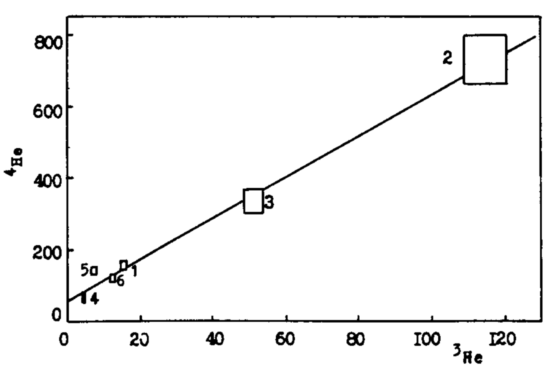

Fig. 1. ^{4}He vs. ^{3}He for six selected H chondrites. The numbers correspond to those in Table 1. The sizes of the rectangles correspond to the errors ±5% for ^{3}He and ±10% for ^{4}He. The line was calculated according to [10].

The value of the A coefficient corresponds to the quantity of ^{4}He accumulated in the meteorite at the expense of U and Th decay following the degassing of the parent material. The obtained value of A corresponds to the age of 200 ± 80 m.y. (2σ). This value remains practically the same if we exclude two “extreme” meteorites (Charsonville or Ställdalen). A similar value for the age, 270 ± 30 m.y., was obtained by the Ar-Ar method for the chondrite Charsonville [9].

Poor statistics prevent unequivocal conclusions concerning the H chondrites. Apparently, we may suppose about 2% of that part of the parent body, whence the H chondrites originate, was heated significantly approximately 200 m.y. ago. This heating was caused by a collision with another body and this heating resulted in almost complete loss of radiogenic He from this region of the parent body.

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TABLE 1. Average contents of ^{3}He and ^{4}He (in 10^{-8} cc STP/g) in selected H chondrites with low U, Th-He (T_4), and K-Ar (T_{40}) ages.

Meteorites	^{3}He	^{4}He	T_4*	T_{40}	T_c
ALHA 77259 H5	15.55	155	285	593	10.5
Charsonville H6 (S4)	115	727	553	1046	73
Rose City H5 (S6)	51.6	329	263	988	34
Ställdalen H5	3.6	69	190	1435	2.9
Suwahib (Buwah) H3.8 (S5)	7.82	140	368	859	6.0
Yamato 790746 H	12.76	119	204	744	7.9

T_c are cosmic ray exposure ages; ages are given in m.y.
*^{4}He radiogenic = ^{4}He measured 5 × ^{3}He cosmogenic [5].

TABLE 2. Coefficients of A (in 10^{-8} cc STP/g) and B in the equation of regression line of ^{4}He = A + B × ^{3}He and U, Th-He ages (t, m.y.) corresponding to the value of A for H chondrites from Table 1.

Meteorites	A	B	t
All meteorites (6)	55.6 ± 10.8	5.8 ± 0.8	196 ± 39
Same as 1, omit Charsonville (5)	56.1 ± 13.9	5.7 ±1.3	197 ± 48
Same as 1, omit Ställdalen (5)	73.2 ± 17.5	5.2 ± 0.9	257 ± 60